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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Refrigeration Machinery

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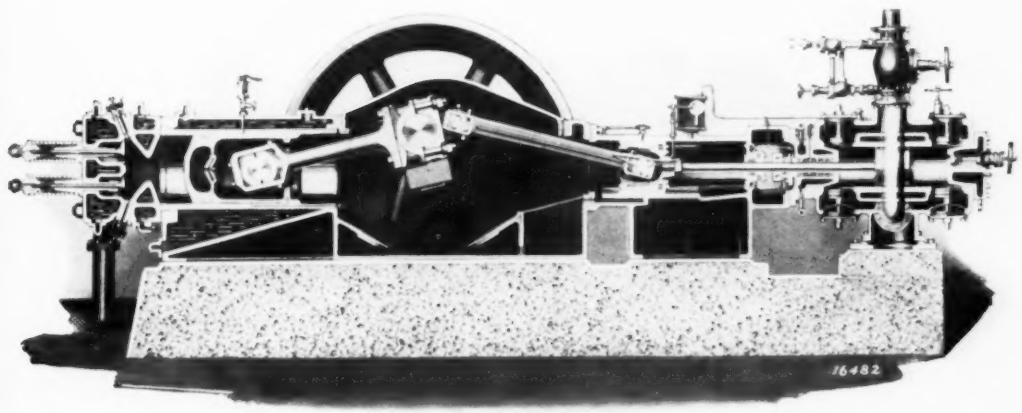


Courtesy of Ingersoll-Rand Co.

Fig. 1.—Sectional View of a Horizontal Oil-Engine-Driven Ammonia Compressor.

Lubrication of Refrigeration Machinery

REFRIGERATION, or the process of mechanical or artificial cooling, is an extensive factor in modern civilization. With 60% of the ice used in the United States today manufactured, with a total of some 25,000 commercial refrigerating plants in operation, and with an investment of over a billion dollars involved, the importance of the refrigerating industry is readily realized.

Refrigeration can be broadly grouped under two classifications, *i.e.*, as applied to:

(a) The manufacture of ice, and
(b) Cooling systems or cold storage plants.

Although their purposes differ to a certain extent, the methods by which these phases of refrigeration are attained are essentially similar. In other words, commercial refrigeration is based upon two phenomena: 1. Evaporation and expansion of the refrigerant, whereby heat is absorbed from the surroundings, and 2. Compression and condensation whereby this heat is in turn abstracted from the refrigerant and the latter again qualified as a coolant.

There are a number of chemicals which are in commercial use today as refrigerants. Of these, anhydrous ammonia (NH_3) or ammonia free from water, is most commonly used. Under normal conditions this chemical occurs as a gas, but by either or both decreasing the temperature and increasing the pressure it may be readily liquified. Other chemicals which are

employed to a certain lesser extent are carbonic anhydride, (CO_2); ethyl chloride, (C_2H_5Cl); Sulphur dioxide, (SO_2); Propane, (C_3H_8); compressed air, etc.

The fact that in refrigeration the cooled product, whether it be ice, water or air, must be free from oil, renders machine lubrication an important factor. The presence of oil in ice will naturally cause the latter to be unsuited for certain household purposes where it must come in contact with foodstuffs. Oil in other parts of a cooling system will tend to reduce refrigerating efficiency due to its becoming so sluggish under the low temperatures involved as to form an interior lining in the expansion coils and materially affect the heat transfer.

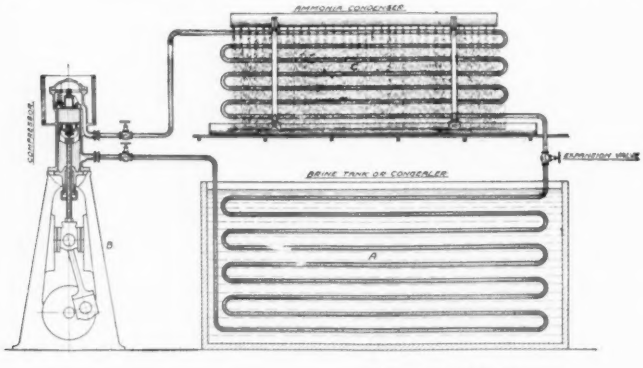
Lubrication of refrigerating machinery is exceptional in that we must consider the action and effects of the lubricants upon parts not requiring lubrication, rather than upon the actual wearing surfaces. As a result, considerable care and judgment must be used in selecting the lubricants.

Methods of Refrigeration

While there are a number of various types of refrigerating machines in more or less common use, they all can be definitely grouped into two distinct classifications, according to the methods involved, *i.e.:*

1. Where refrigeration is produced by the evaporation of some volatile liquid.

2. Where refrigeration is effected by the compression, cooling and expansion of air.



Courtesy of Frick Company

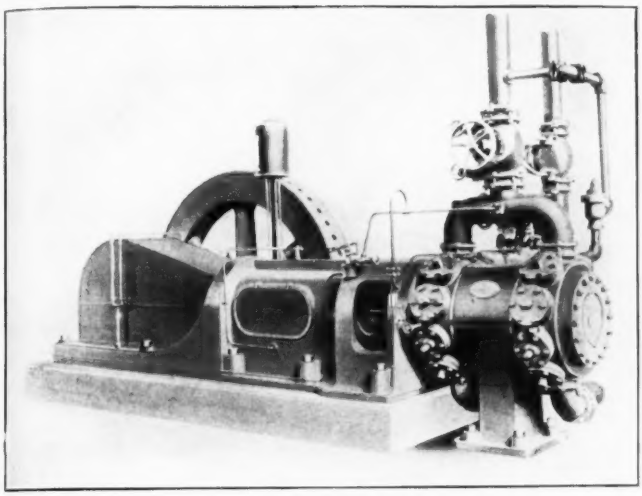
Fig. 2.—Diagrammatic arrangement of a refrigerating system involving the principles of ammonia compression. The relation of the essential parts to each other is clearly shown.

The first classification can be sub-divided into three groups, according to whether the principles of (a) compression (b) absorption, or (c) vacuum, are employed.

Compression Systems

The compression process is chiefly used today. Essentially a compression system includes a compressor, oil separator, condenser, expansion valve, and an evaporator or refrigerator. Compressors may be either single or double acting according to the size of the installation and extent of refrigeration required. In the compression process the refrigerant or cooling agent is recovered after each expansion by means of mechanical compression. With certain variations in construction and arrangement of equipment, the compression process is adaptable to such refrigerating agents as ammonia, carbonic anhydride, ethyl chloride, propane and sulphur dioxide, etc.

In operation, the gaseous refrigerant in a compression system must be sufficiently compressed and cooled to convert it to liquid form. Under compression alone it will still remain as a gas, due to the fact that the application of pressure raises the temperature above the liquefaction point. Some form of condenser must therefore be used. Prior to condensation, however, the gas is usually passed through a suitable oil separator or trap in order to free it of any excess lubricant that may have gained entry into the compressor. From the oil separator the hot refrigerant then passes to the cooling coils of the condenser where its temperature is sufficiently lowered by means of cold circulating water, to convert it to liquid form. It is then capable of serving as a cooling medium. This is brought about by passing it through an expansion or regulating valve to the expansion side of the system. Here by virtue of a considerable drop in pressure it evaporates and returns to its normal gaseous state. In so doing it cools down to a relatively low temperature and as a result absorbs heat from the surroundings, whatever these may be. It is then returned to the compressor to commence this cycle of operation anew.



Courtesy of the Vilter Manufacturing Co.

Fig. 3.—A Double-Acting, Horizontal, High Speed Ammonia Compressor. Note tank and piping for the automatic lubrication system.

Ammonia as a Refrigerant

In the application of ammonia to refrigeration purposes, it can be handled by either one of two methods, *i.e.*, by wet or by dry compression. Wet compression is attained either by the introduction of liquid ammonia directly into the compressor cylinder at the beginning of the compression stroke; or, by operating so that somewhat more liquid ammonia than can be evaporated is passed into the refrigerator coils. Subsequently this liquid returns to the compressor with the balance of the refrigerant which has been vaporized, and is itself evaporated on the suction stroke by the heat of the compressor. Its presence serves to effectively decrease compression temperatures, and increase the volumetric efficiency.

In a wet compression system, however, the operator can never be certain that the excess liquid has become completely vaporized at the end of the suction stroke, regardless of the attention given to the machine.

Dry compression constitutes the passing of ammonia vapor alone into the compressor. On this account a slight degree of superheat is usual. Dry compression involves the same operating principles as wet compression with the exception that discharge temperatures are somewhat higher. Usually these will range from 40° to 60° above the corresponding temperatures in wet compression machines.

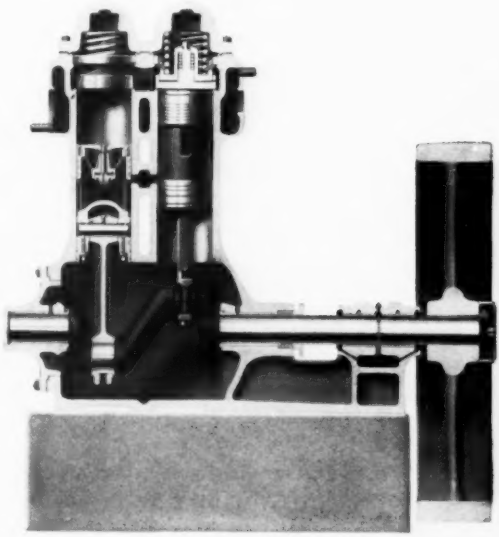
Lubrication of Ammonia Compression Systems

In the selection of lubricants for an ammonia compression system there are three characteristics that must be present, *i.e.*:

1. Low pour test.
2. Comparatively high flash point.
3. Suitable viscosity.

The exact nature of these in any case, however, will be governed by such operating and constructional conditions as:

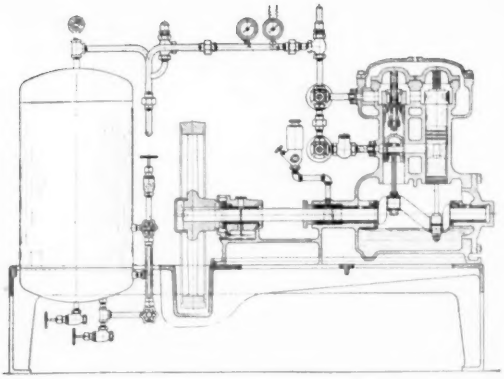
1. The method of lubrication,
2. The temperature in the refrigeration coils,
3. The mechanical condition of the valves, cylinder walls, pistons and rings, and
4. The location, type and efficiency of the oil separator and piping.



Courtesy of York Manufacturing Co.

Fig. 4.—Section of a Vertical Enclosed Ammonia Compressor, showing the working parts.

An ammonia compressor lubricant must remain sufficiently fluid at the minimum temperature in the expansion or refrigerating side of the system as to resist congealment, and at the same time have a high enough flash point to insure against distillation or "cracking" at the discharge temperature. Flash point, however,



Courtesy of Frick Company

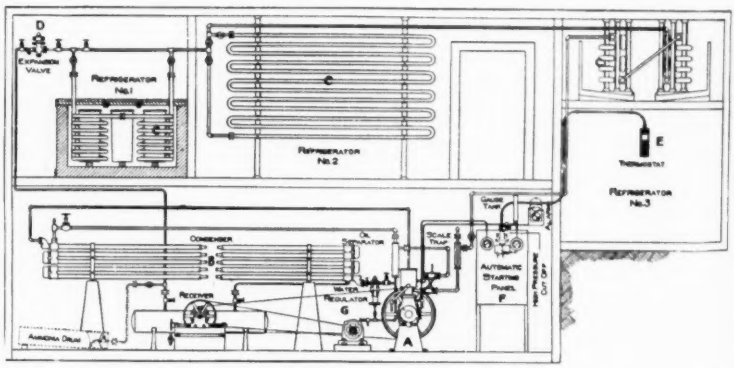
Fig. 5.—Sectional View of a Two-ton Ammonia Compressor showing connections and operating parts.

in a wet compression system is of little concern, inasmuch as discharge temperatures are always considerably below the flash points of the usually accepted compressor oils.

In dry compression systems the flash point of the compressor lubricant is of somewhat more concern on account of the higher cylinder temperatures involved. An oil suited to this class of service should have the customarily low pour test in order that it will remain fluid at the lower temperatures encountered in the evaporating side of the system and not congeal on the inner surface of the cooling coils; a flash test above the highest prevailing discharge temperatures, and sufficient viscosity throughout the range of operating temperatures to enable it to serve at all times as an effective lubricant for the moving parts, as well as an adequate seal for piston rings and compressor valves. For such service a filtered straight mineral oil having a viscosity of about 100 seconds Saybolt at 100° F., will be necessary where the temperature in the refrigerating coils is below —5° F. Above this temperature, however, an oil of somewhat higher viscosity, *i.e.*, 200 seconds Saybolt, will give satisfactory results.

It is generally advisable to always use the purest grade of straight distilled mineral oil obtainable, in order that the above requirements will be adequately met. Oils of this nature will have a sufficient range of physical properties to lubricate compressors effectively under all normal operating conditions. Mineral oils are more suitable than compounded lubricants inasmuch as both animal and vegetable oils in compound will not only have a tendency to congeal at low temperatures and gum at higher temperatures, but will also react with ammonia. In addition they will tend to produce free fatty acids which will not only attack the wearing surfaces of the compressor cylinders and pistons but as well will react with ammonia gas to cause the formation of sludge.

Water is another factor that must be given consideration. It is essential that the lubricant at all times be practically free from water, otherwise this will freeze if carried over to the refrigerator coils in which case it would probably remain in the system and result in a certain decrease in evaporation efficiency. It is therefore necessary for operators to use the utmost care in placing oil cans beneath snow-covered suction pipes, etc., or anywhere else where moisture might splash or drip into the contents. An excess of water can readily cause so much trouble in the evaporator coils that the plant may have to be shut down to correct this.

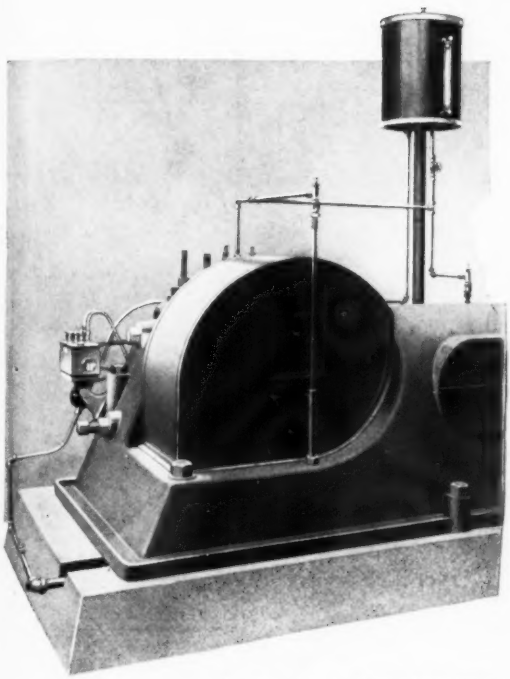


Courtesy of the Automatic Refrigerating Co.

Fig. 6.—Arrangement of a Typical Ammonia Refrigerating System, showing accessory apparatus and the principles of arrangement.

The Relation of Viscosity

From the viewpoint of compressor lubrication, viscosity is of chief concern to us. Viscosity of a compressor oil must be low, the more especially when we are dealing with enclosed



Courtesy of De La Vergne Machine Co.

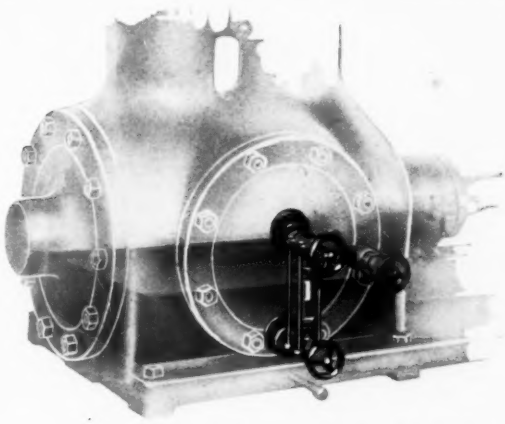
Fig. 7.—Automatic Oiling System for a high speed compressor, which provides a constant stream of oil to the main bearings, crankpins, crosshead pin and guide.

case, high speed machines of the wet compression type. In such equipment higher viscosity lubricants will tend to form a froth or emulsion with the refrigerant. To a certain extent emulsions of this sort serve as lubrication for the cylinder walls, due to their adhesive nature. In excess, however, this froth or emulsion will fill the crankcase and pass by the piston and into the system where clogging may ultimately occur.

To a large extent the physical condition of the cylinder walls, valves, piston rings and stuffing box, will determine the viscosity of the oil we must use. Practically as important as its lubricating properties is its seal and compression forming ability.

If the cylinder wall and moving parts are in first class condition a straight mineral oil of approximately 100 to 150 seconds Saybolt viscosity at 100° F. will be suitable.

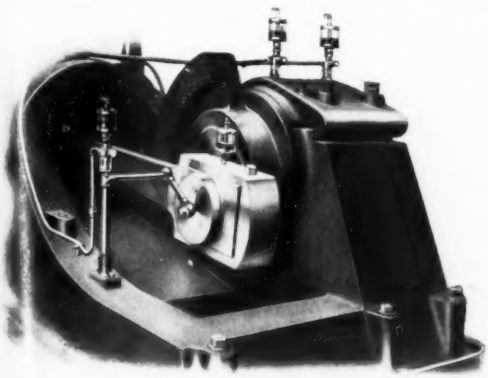
The more worn and scored the cylinder walls and rings, naturally the higher must be the viscosity (within practical limits) to maintain the requisite seal and degree of compression. Usually an oil having a viscosity of from 150 to 200 seconds Saybolt at 100° F. will be satisfactory in this event. Horizontal compressor cylinders will have a greater tendency to wear out of round than those in vertical machines,



Courtesy of York Manufacturing Co.

Fig. 9.—Phantom View of the Crankcase of a Vertical Compressor wherein splash lubrication serves the shaft bearings, crankpin bearings and the ammonia piston and pin. The gauge glass shows the oil level in the case.

due to the weight of the piston on the under walls. Therefore, such compressors will in general require a somewhat heavier lubricant. It is not advisable to attempt to compensate for wear by increasing the viscosity too much.



Courtesy of Frick Company

Fig. 8.—Showing the arrangement of the main bearing in the engine frame, with the provisions for lubrication.

The Oil Separator

On the other hand, an excess of lubricant fed to the compressor will tend to impose a heavy load upon the oil separator, and if this is not drained or blown back into the compressor case at frequent intervals, a certain amount of oil will find its way over into the evaporator coils, reduce the capacity of both the condenser and evaporator, and necessitate blowing out the

system. In certain types of vertical compressor systems it is recommended that the oil separator be blown back when the oil gauge on the compressor shows the oil level to have dropped to approximately one to two inches from the bottom of the glass. Blowing back should only

Courtesy of The Vilter Manufacturing Co.

Fig. 10.—A Standard High Pressure Oil Trap which can be located anywhere in the main discharge line between the compressor and ammonia condenser.

be done when the compressor is in operation, and the oil return valves should be closed immediately the oil separator gauge shows no oil, else ammonia will pass to the compressor case and cause abnormal pressure therein.

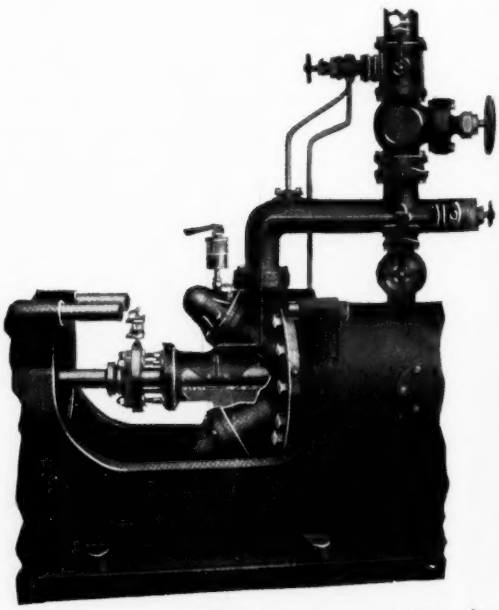
The location of oil separators or traps is frequently important. The number installed may vary, but at all events a main separator should be placed between the compressor and the condenser, with additional auxiliary separators or traps at the lowest points of the condenser and evaporator coils. Where the main oil separator fails to function properly, the reason is often because it is set too near the compressor, and the rush of hot gas prevents condensing of the oil.

A certain amount of evaporation of the lubricant will always take place by virtue of the heat of compression which is prevalent, regardless of how high the flash point may be. This oil vapor will therefore tend to pass into the system with the refrigerant, and condense and remain in the colder parts, unless it is effectively removed before it enters the condenser.

It is therefore best to locate the separator close to the condenser. It should be of sufficient size to allow ample reduction in velocity of the gas in order to permit of effective separation. A small separator located some distance from the compressor may often prove less effective than a large separator set near by.

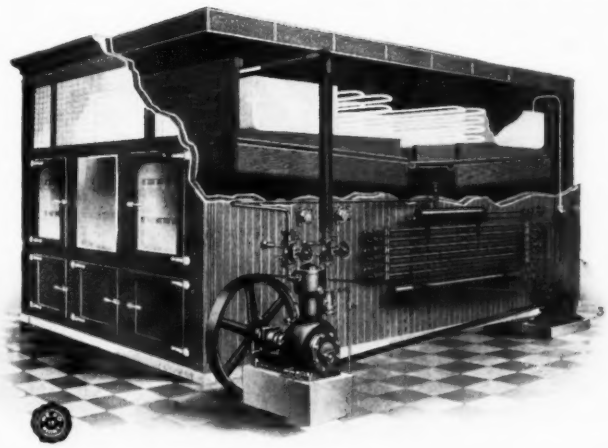
Where it is impossible to locate the main oil separator elsewhere than adjacent to the compressor, it is well to use an oil of as low an evaporative tendency as possible. Usually low evaporation accompanies high viscosity; hence the choice of a heavier oil would solve the problem to some extent. In general a viscosity of about 200 seconds Saybolt at 100° F. will be best under such conditions.

It is possible to check up the efficiency of an oil separator by comparing the amount of oil removed from it with the amount fed to the compressor. Any extensive difference would indicate that the oil is not being entirely



Courtesy of The Triumph Ice Machine Co.

Fig. 11.—A stuffing box arrangement which illustrates the principles of compressor lubrication by means of an oil lantern.



Courtesy of the Arctic Ice Machine Co.

Fig. 12.—Assembly View of a Meat Market Refrigerating Plant.

trapped. Due allowance should be made however, for leakage around the stuffing box.

Stuffing Box Seals, etc.

One of the most important factors in ammonia refrigeration practice is to maintain suitable stuffing box seals and properly lubricated piston rods to attain best results. It is necessary to remember that ammonia has a certain corrosive action upon copper and bronze; and that mineral oils destroy rubber. Therefore, stuffing boxes are usually built of cast iron or steel (as are other parts of the compressor) and metallic (babbitt-metal) or asbestos packing is used. To effectively lubricate the piston rod in some types of machines a hollow space or "oil lantern" is located between two separate sets of packing. This space surrounds the rod and is filled with oil. The lubricant is usually fed to the "oil lantern" by means of a hand or automatic pressure oil pump. Where the piston rod is efficiently lubricated, its surface will have a smooth gloss, and will be covered with a light film of oil; there will be no indications of overheating and a relatively perfect seal will be maintained.

The "oil lantern" serves also as a means of introducing the lubricant to the compressor cylinder in some types of double-acting machines by allowing it to work past the packing. There is an added advantage to this method in that the lubricant serves to protect certain grades of packing from the injurious effects of ammonia gas.

Other manufacturers design their compressors for force feed lubrication, and install a positive force feed lubricator which is driven from the reciprocating mechanism through suitable connecting links. Force feed lubrication is advantageous in that the amount of lubricant supplied to the compressor is dependent upon the speed of the operation. Thus, by careful adjustment and correction it is possible to feed a definite quantity of lubricant at each stroke and at just the right time to be most effective. Force feed lubrication is, therefore, depend-

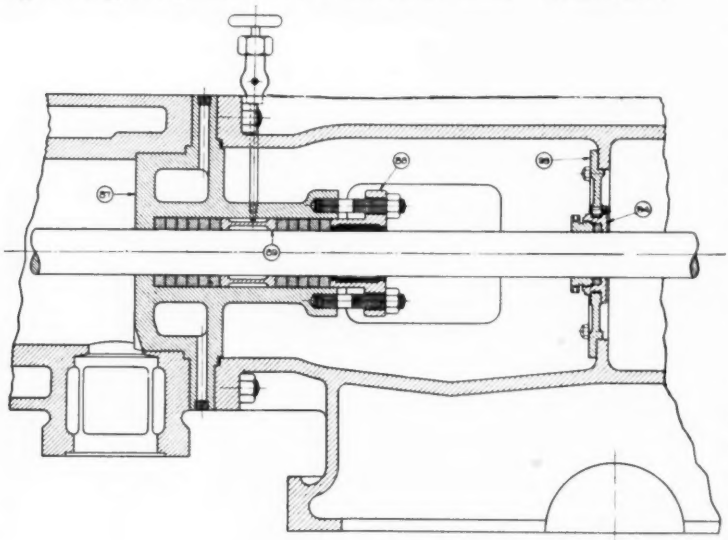
Courtesy of Brunswick-Kroeschell Co.

Fig. 13.—Cut-Away View of a Vertical Ammonia Compressor. Interior construction is clearly shown.

able, economical and requisite of little attention on the part of the engineer, excepting when it is necessary to refill the lubricator.

External Lubrication

The lubrication of so-called external parts of the average compressor such as crank pin, bearings and guides, involves few difficulties as a rule. Automatic lubrication is often customary and splash or force feed application is usually employed.



Courtesy of the Arctic Ice Machine Co.

Fig. 14.—Sectional Elevation of the Front Head and Oil Splash Head on one type of horizontal ammonia compressor. 87 shows the front head; 88 the packing gland; 89 the oil sleeve; 93 the oil splash head and 94 the stuffing box.

Splash lubrication is prevalent in many types of vertical compressors, and the one oil frequently serves both the compressor cylinder and the bearings, in much the same manner as in an automobile engine. Where splash lubrication is customary it is important to watch the oil level in the crankcase carefully and never let it get too high. If this does occur abnormal churning may arise with consequent introduction of excessive oil into the refrigerating system. Outboard bearings of vertical compressors can be efficiently lubricated by ring or chain oilers, using the same oil as in the compressor itself.

Horizontal compressors and certain larger types of vertical machines are usually equipped with a gravity or force feed circulating system, which furnishes a continuous stream of oil to all bearings beyond the compressor. Such systems generally include a suitable oil filter, overhead storage tank (which allows for gravity feed), water separator and geared pump. This latter is installed in the base of the crankcase, being driven from the compressor itself. Oil is filtered prior to each circulation, and therefore is capable of giving efficient lubricating service at all times.

Vacuum and Absorption Systems

Vacuum and absorption refrigeration systems involve pumps instead of compressors, one working below atmospheric pressure, the other above.

The Vacuum Process

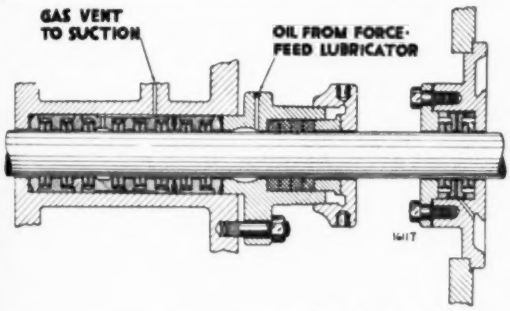
In the vacuum process water usually serves as the refrigerant due to its relative cheapness and the fact that no attempt is made to recover the refrigerant. Water, however, can only be used where the vacuum is as nearly perfect as possible because of the rapid increase in its temperature of vaporization with increase in pressure. Hence, where it might not be desirable to operate under vacuum, other refrigerants should be used. The vacuum process is based on the fact that under reduced pressures water will give up its own latent heat and produce evaporation. The evaporation of about one-fifth the original volume of water is required before freezing results.

Refrigeration by Absorption

The absorption process makes use of the fact that certain low boiling point vapors are readily absorbed by water, being capable of subsequent separation by fractional distillation upon the application of heat. Ammonia is principally used in absorption refrigeration due to its relatively high affinity for water and the readiness with which it can be distilled off under pressure and temperature conditions where water is unaffected. The latter is, therefore, able to remain in a liquid state.

Absorption and compression processes are similar with the exception that in the former the return from low to high temperatures is attained by the application of heat instead of mechanical compression.

Absorption refrigeration involves three stages or sets of equipment, whereby the ammonia is first distilled in a suitable steam heated generator, freed from any water vapor in an analyzer, and liquified by passage through a suitable condenser. It is then ready for the second, or refrigeration, stage, being passed to an evaporator or set of cooling coils. The third stage usually comprises the passing of the gaseous ammonia under its own pressure, to an



Courtesy of Ingersoll-Rand Co.

Fig. 15.—Stuffing Box arrangement for an Ammonia Compressor, showing oil lantern.

absorber, where it is taken up by a weak ammonia solution. When suitable concentration of the latter has been attained it is pumped back to the generator, and the cycle begun anew.

In certain instances the principles of compression and absorption refrigeration may be combined in the same system.

Lubrication of Vacuum and Absorption Systems

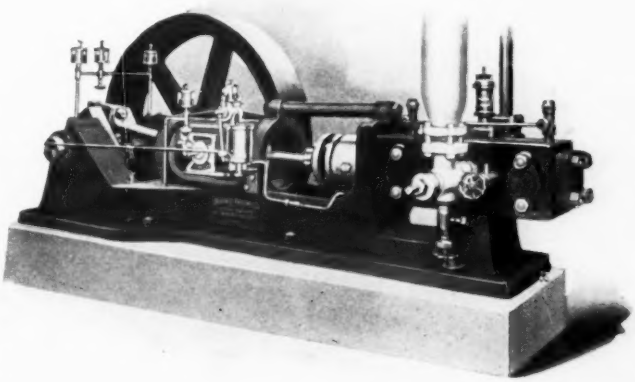
In both these systems pumps are the only mechanisms requiring lubrication, and the possibility of difficulties arising is remote. The vacuum pumps employed in the vacuum system require merely sufficient viscosity in the lubricant to insure the preservation of a suitable seal between the piston rings and cylinder wall. From 200 to 300 seconds Saybolt at 100° F. will usually suffice.

Lubrication of such pumps as are employed in an absorption system is likewise comparatively free from difficulty. Only when the exhaust from steam driven pumps is to be used for ice making or other purposes requiring water free from oil, must we be careful as to the grade of steam cylinder oil used and its application, in order to insure against an excess of oil passing over into the exhaust and perhaps discoloring the ice or cause contamination in other respects.

Carbonic Anhydride Refrigeration

Refrigeration by means of Carbonic Anhydride (CO_2) involves an arrangement of machinery and equipment much similar to an ammonia compression system. In fact the essential difference (other than in regard to certain details of construction in view of the higher pressures involved) is in the cooling medium or refrigerant employed. Carbonic Anhydride or Carbon Dioxide, as it is more commonly termed, has certain marked advantages over ammonia in that it is non-poisonous, non-explosive, odorless, non-combustible, less expensive, a fire extinguisher, and neutral in its action upon food stuffs, fabrics and other substances which may require cold storage. Therefore, leaks are far less to be feared, even though they may be more prevalent due to the higher pressure involved.

Carbonic Anhydride systems include both horizontal and vertical compressors according to the type of service and refrigerating capacity involved. Single and double acting com-



Courtesy of Brunswick-Kroeschell Co.

Fig. 16.—A Carbonic Anhydride Compressor of the center crank type.

pressors are in use, but due to the difficulty in maintaining tight stuffing boxes, the single acting machine is often preferred. Frequently pressures as high as 1000 lbs. may be necessary; therefore, it is evident that the system must be of exceptional rigidity.

Lubrication of Carbonic Anhydride Compressors

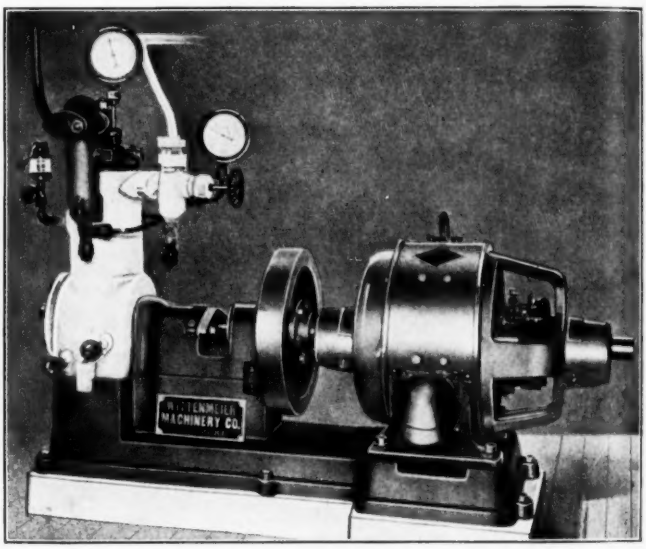
While the principles of construction and operation are essentially similar in both ammonia and carbonic anhydride compressors, the marked difference in pressures often requires separate consideration from a lubricating viewpoint. The lubricant should be a straight mineral oil having essentially the same characteristics as for a dry ammonia compression system, such as: low pour test, a flash point sufficiently above the discharge temperature to insure against distillation, and a viscosity in the neighborhood of 100 to 200 seconds Saybolt at 100° F. dependent upon operating conditions and the design of the system. Carbonic anhydride compressor cylinder temperatures are usually somewhat higher than ammonia compressor temperatures due to the higher pressures involved.

Mineral oil has no affinity for carbon dioxide, therefore there is little or no possibility of its being carried over into the condenser unless it is vaporized, which is but a remote possibility. To insure against any oil whatsoever passing over into the system, an oil trap is usually installed in the discharge line from the compressor. Stuffing boxes are built similar to those on a double-acting ammonia compressor, with the exception that more compartments are necessary due to the higher pressures involved.

The stuffing box is sealed and the piston rod oiled by means of forced feed lubrication. The same lubricator usually serves the valves and piston as well. The feeding of a suitable amount of lubricant to the stuffing box prevents loss of gas. The lubricator must be very carefully adjusted at all times, however, the same as for an ammonia machine, since the feeding of an excessive supply of oil will often result in a certain amount of it passing to the gas relief line and from thence into the system.

Miscellaneous Other Refrigerants

Among the other substances which are used to some extent in certain classes of refrigeration, ethyl chloride, methyl chloride, propane and sulphur dioxide predominate. In each case their action is similar to ammonia and the principles of application, such as liquefaction, compression and evaporation, differ but little.



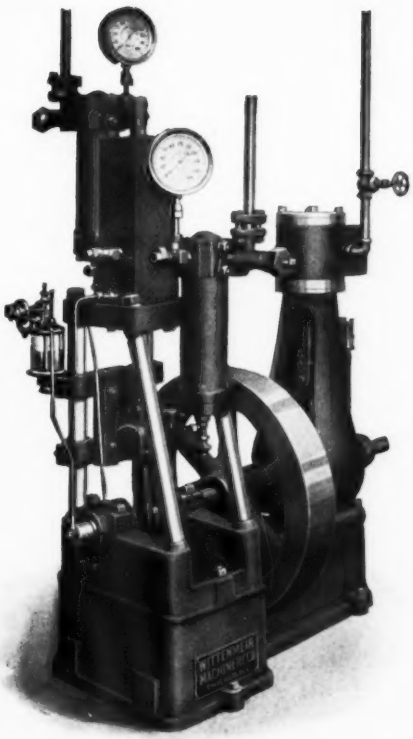
Courtesy of Wittenmeier Machinery Co.

Fig. 17.—An enclosed Carbonic Anhydride Compressor direct connected to a motor.

Ethyl Chloride

Ethyl chloride is a very stable, non-poisonous, slightly inflammable chemical, readily subject to low working pressures. It is chemically neutral, having no effect on the usual metals employed in machine construction, nor has it any reaction with air or water.

The ethyl chloride compressor is usually of the rotary type. Compressors of this nature are especially suited to service where comparatively large volumes and low pressures are involved. They contain no valves or other small mechanisms to foul or get free and perhaps interfere with the operation of the working parts. The essential feature of the typical ethyl



Courtesy of Wittenmeier Machinery Co.

Fig. 18.—A Vertical Marine Type CO_2 Compressor, connected directly to a steam engine.

chloride compressor is a rotor installed eccentrically in an elliptical shaped cylinder. The rotor is in close contact with the top of the cylinder and makes a seal between the suction and discharge ports. The rotor is equipped with four equidistant blades, the tips of which are fitted with packing strips; these make contact with the cylinder wall. Each end of the rotor shaft is carried in a solid bearing fitted with bronze bushings.

Lubrication

Due to the solubility of mineral oils, ethyl chloride compressors require the use of chemically pure glycerine as the lubricant. In serving the machine, the glycerine passes through a continuous positive cycle. The commencement of the cycle is the transmission of the lubricant to each end of the compressor and thence via ducts to the bearing compartments. The rotor blades pick it up at this stage and carry it into the cylinder from whence it is discharged with the compressed gas to the condenser and separator. In the latter, the glycerine being the heavier, is separated from the refrigerant. From the separator it is again forced to the compressor and the cycle begins anew.

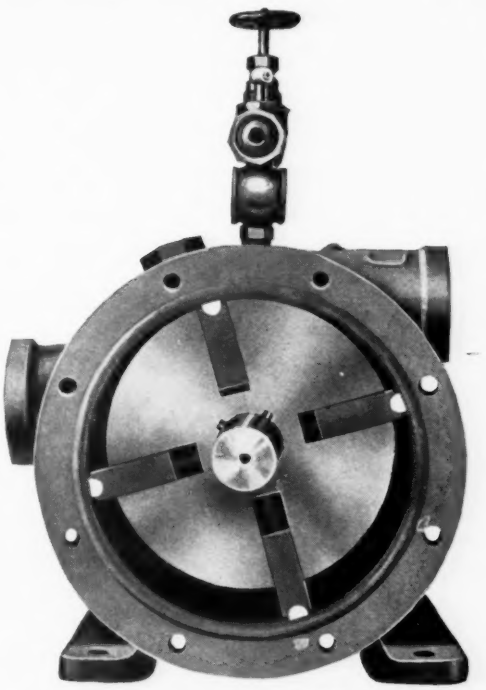
Sight feed equipment is installed in the lubricating circulating system to enable observation of the flow of lubricants at all times.

Methyl Chloride

Methyl chloride is another relatively low pressure refrigerant which functions, and is handled, in a similar manner to ethyl chloride. Lubrication requirements are also very much the same, and chemically pure glycerine is generally regarded as the most suitable lubricant.

Propane

Propane is a hydro-carbon refrigerant which is coming into use, especially for household and retail business purposes. This chemical has a distinct property in that lower temperatures are made possible by its application. Propane requires less pressure for compression, and gives lower temperatures than ammonia, with the same back pressure.



Courtesy of The Clothel Company

Fig. 19.—A Rotary Type Ethyl Chloride Compressor showing details of the rotor and blades.

Propane is non-corrosive, chemically neutral towards water, relatively stable, under ordinary conditions non-poisonous, and can be handled in the same equipment as is required for ammonia. It is, however, inflammable in the presence of open flames.

In order to effectively lubricate a propane compressor, we must select a lubricant that is relatively insoluble in this chemical. The determination of the most suitable lubricant is now being investigated. So far, experiments with castor oil, lard oil and certain glycerine blends have developed that satisfactory compounds can be produced which will effectively lubricate under ordinary conditions.

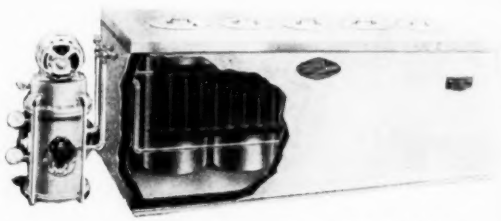
Sulphur Dioxide

Many smaller refrigerating systems are designed to use sulphur dioxide as the refrigerating medium. As a liquid, sulphur dioxide is colorless. It is soluble in water, in which solution it is strongly acidic. While poisonous, it is not usually regarded as dangerous when employed for refrigeration purposes.

Sulphur dioxide, like some other low pressure refrigerants, has a decided affinity for certain of the hydrocarbon components in mineral lubricants. However, it is entirely possible to specially treat mineral oils of higher viscosities, the removal of the component parts affected by sulphur dioxide rendering the residual oil quite satisfactory as a lubricant. Usually an oil having a viscosity of about 700 to 900 seconds Saybolt at 100° F. is preferred for such service. On the other hand, it is often customary to use glycerine or glycol as the lubricant. The latter has by far the lower pour test, and if compounded with deflocculated graphite, is quite satisfactory. Chemically pure glycerine is, however, suitable for all ordinary purposes.

Conclusion

While other refrigerants may be employed, the above comprise those with which we will usually have to deal. Air has not been discussed owing to the fact that refrigeration by means of the compression, cooling and expansion of this medium is so distinctly different



Courtesy of the Clothel Company

Fig. 20.—A Vertical Propane Compressor attached to an ice cream tank. Details of tank are shown in cut-away portion.

as to be worthy of independent treatment. We will, therefore, deal with the lubrication of the so-called dense air machine, etc., in a future issue of LUBRICATION.

In regard to ammonia, carbonic anhydride and the other more usual refrigerants discussed above, operating conditions have been discussed only so far as they involve lubrication, and just sufficient description of design and construction has been undertaken to give the reader an intelligent idea of refrigeration as a whole. The salient feature of refrigerating efficiency is lubrication. Therefore we have dealt extensively with the subject from this viewpoint in order to aid the engineer in making a proper selection of lubricants for his system, and to impress upon all concerned that quite as important as the lubrication of refrigeration machinery is the detrimental effect that the lubricant may have upon other parts of the system if it gains entry therein.

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